The Impact of the Residential Reconstruction Projects on nearby Property Values : A Case of Songpa-gu, Seoul

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Abstract

This study analyzes the impact of housing prices on nearby houses by phase of housing reconstruction. Existing prior studies have analyzed the effect of fundamental changes in neighborhood prices, such as housing redevelopment or 'New Town' project. Also, the prior papers related to housing reconstruction did not carry out generalizable analyses, they are based on case studies. This study classified the 16th phase of housing reconstruction into 4th phase through the operational definition. Subsequent steps were followed by an analysis of how residential prices in the neighborhood were affected.

The analysis method used a hierarchy-linear hedonic model. This study was analyzed based on the prices of apartments that are common to houses, especially Seoul. Therefore, the model was used to control the effects of the apartment complex.

The finding of this study is as follows. 1) The role of the reconstruction apartment stage is different, and the effects of each stage are also different. 2) Depending on the extent of the surrounding neighborhood like neighborhoods in 400m or 800m, the impact of changes in the housing reconstruction is different. 3) Differences in impact are related to the classification of neighboring housing markets. The effect of the sale is different on the basis of the 20 years of construction. This is related to the progress of nearby reconstruction on the grounds that it can determine expectations of possible reconstruction. This may have affected the market with expectations of possible reconstruction and the possibility of replacement by new housing. In the case of Rent Market, the market is affected by physical changes, such as Move-in to apartments where migration demand and reconstruction have been completed as the reconstruction process progresses.

However, the study was conducted only on Songpa-gu in Seoul. Therefore, it is difficult to draw up implications for the overall Seoul reconstruction market. Also, it is difficult to derive a clear understanding of whether the peripheral effects of reconstruction are short-term or long-term.

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I. Introduction

1.1 Research Background

According to the National Statistical Office (2017), Seoul currently has about 3.949 million households and 2.86 million homes. That is, compared with the number of households that are in demand, the number of houses is insufficient. However, the price of housing in Seoul recently went through a steep rise. According to report released by KB Financial Institute (2018.04), prices of reconstruction apartments rise due to the absence of new housing supplies due to strict regulations on real estate fields and the shortage of new housing supplies. Recently, due to Seoul City's regulations, the reconstruction of large apartment complexes has been delayed. To achieve its goal of blocking the possibility of rising housing prices, the government is imposing and delaying reconstruction.

In order to comprehensively understand this phenomenon, an understanding of the market changes resulting from the readjustment project is necessary. Redevelopment, one of the representative readjustment projects, is a project implemented within redevelopment zones for the improvement of residential environment in areas where dilapidated housing is concentrated or public facilities are poorly maintained for the rational and efficient use of land and urban functions. (도시 및 주거환경정비법 제1장 제2조) In the case of a housing redevelopment project in which the improvement of the surrounding residential environment is jointly conducted, it can be seen as a development that could have an effect on environmental improvement in the surrounding neighborhood. Housing redevelopment could affect the surrounding area by rebuilding the area with poor infrastructure. In other words, prior studies have been conducted on changes in nearby neighborhoods, not in the form of changes in one building, such as the development of a similar type of new town. (Kim, 2006; Oh & Jin Nam-seok, 2009; Choi Sung-hyun, 2017) However, 'Housing Reconstruction Project' is a project that is implemented to improve the residential environment in areas where the infrastructure is good but old or badly housing condition. In other words, it is not an actual or physical change in the area in which the building is located, because only that building is changed.

The need for research has been derived from the view that housing prices have been increasing in recent years and that reconstruction has been pointed out as a factor in the rise in housing prices. In implementing the reconstruction, it is not easy to proceed with the reconstruction process by strengthening the requirements for safety diagnosis and implementing the return of excess profits. The supply of new apartments is also not being made properly in existing areas of Seoul, except for the green belt. Choi(2005) said that since housing has a property of value goods rather than public goods, the regulation on reconstruction should also be made from the perspective of value

goods rather than public goods. In this context, the housing demand in Seoul where people gather increases, and if there is no increase in supply, the price rises. Rather, more housing reconstruction could be a policy measure against rising housing prices.

However, when housing reconstruction is under way, there will be a lot of news and promotion through banners celebrating reconstruction around apartments as described in [Figure 1]. These activities have the potential to affect the surrounding market as well. A theory that explains people's choices under uncertainty is 'Prospect Theory'. This theory assumes that people respond to change, then uses it to quantitatively analyze expectations of uncertainties in housing prices. (Jo Joon-hyuk, 2011) That is, the expectation of an information acquisition resulting from changes in the surrounding market may affect housing prices. Therefore, it is necessary to identify the impact of these factors on housing prices and propose a reconstruction policy to ensure correct housing price stability.

Figure 1. An Example of Promoting Housing Reconstruction[1]

1.2 Research Purpose

The study analyzes how the price of neighborhood housing is affected by the progress of a housing reconstruction. Since all of the stages of reconstruction have different roles, it is necessary to see how each phase of implementation affects the surrounding residential market.
Also, the affected peripheral housing market needs to be divided into the sales and rent markets. For the rent market, the value of use is the price that includes value in use, whereas sales market is the price that includes value in use and investment. (Lee & Lee, 2015) It is necessary to separate the transaction price from including other forms of value. In addition, it is required to separate the

[1] "압구정 구현대 추진위 구성…재건축 시동," Chosun Biz, last modified Mar 26, 2017, accessed Aug 11, 2018, http://biz.chosun.com/site/data/html_dir/2017/03/26/2017032601754.html?Dep0=twitter

markets according to the number of construction years. Previous studies have shown that if the number of years of construction goes beyond a certain period, expectations of possible reconstruction have an impact on the sale price. (Yoon, 2009; Lim, 2009; Sung & Park, 2014) Based on this study, it was assumed that, on the basis of 20 years, the expected value of possible reconstruction varies from apartment complexes. This study process can be shown through the [Figure 2] below.

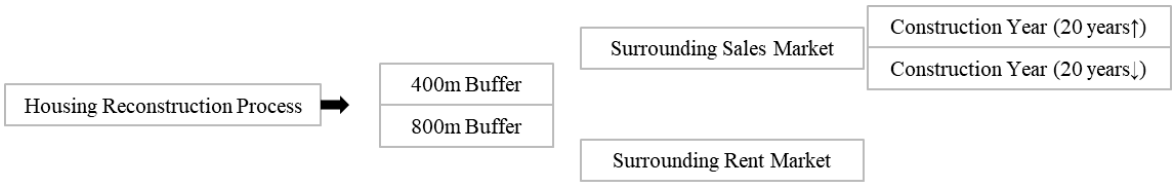

Figure 2. Conceptual Model of the study

Therefore, the questions in this study are:

Research Question 01. According to the stages of housing reconstruction, the impact on the housing sales market within 400/800 meters around the site is demonstrated.
Research Question 02. According to the stages of housing reconstruction, the impact on the rent market within 400/800 meters is demonstrated.

II. Literature Review

2.1 House Reconstruction Progress Phase

The majority of the preceding studies related to housing reconstruction were mainly conducted on combating the member of an association that occurred during the phase of the reconstruction process, development benefits or the cost of reconstruction and the feasibility of the reconstruction (Kim et al, 2011; Lee, 2014; Kim & Lee, 2015; Hong & Jung, 2018)
In this study, the research would understand how the price of surrounding houses is affected by the ongoing reconstruction phase. Prior to this, a definition of the stage of reconstruction is needed. In the preceding studies, 16 steps of reconstruction were defined for research purposes as appropriate criteria for research purposes such as conflict, development benefits, and construction burdens.
First, the progress of the housing reconstruction project is shown in the following [Figure 3].

Figure 3. The progress of the housing reconstruction project

Within the above steps, Oh & Lee (2004) classified the process of promoting reconstruction into four major stages. Stage 1 was set to the period of three months before the safety diagnosis, when the decision to rebuild was affected. Step 2 is the period that affects the passage of the safety diagnosis. The period from the safety diagnosis to the period immediately preceding approval of the combination was set. Stage 3 was set to the point immediately before the project approval was granted after the approval of the cooperative establishment, as the effect of the union's approval was affected. Stage 4 was set to the period of 4 months after the project approval was granted. This is a phase from the approval of the project to the start of construction. Ahn (2008) divided the reconstruction process into three stages: preparation, construction and closing like move-in. Preparation steps include organizing a promotion committee and safety diagnosis. The construction stages include the establishment of a cooperative, the selection of a contractor, approval of a project plan, migration, and demolition. Finally, the closing phase was defined as the phase of sale, completion, and entry. Kim et al (2011) studied the promotion stage of the housing redevelopment project. So, the project planning stage was considered to include designation of readjustment zones, and the construction stage was moved to completion of the construction phase, including the establishment of a cooperative. The stage where conflicts occur at high rates was high, such as establishment of unions, disposal plans, or execution of projects. Ahn et al (2011) divided the reconstruction process into planning and design phase, implementation and accreditation phase, construction and completion phase. During the planning and designation phase, the basic plan was evaluated by dividing the approval of the cooperative establishment promotion committee into the construction and completion phase of construction and completion of the plan. Kwon et al (2012) discussed major problems with the reconstruction project, and the Commission pointed out that the profitability prediction was not reasonably possible due to the absence of expertise. In addition, in the case of progress of the project implementation approval, there is a possibility that the project committee will lose credibility as it may differ from the proposed union burden through the promotion committee. In Ahn & Jeon (2012), the first phase of the plan including the steps of the promotion committee and the maintenance plan raised the issue due to the lack of forecasts of levies and lack of predictability of profitability. The

second stage of the plan addressed the problems of the lack of a union cost plan and changes in the contractor's proposed construction costs as part of the plan to establish, approve or dispose of the union. The three-stage implementation is a start-up and completion phase, which describes the possibility of increased costs due to design changes and changes in the sale market. In the four-step calculation, the union disassembled and closed, and additional construction costs were considered problems. In a similar way to the preceding research, Kim & Lee(2015) analyzed the conflicts in the refurbishment project by dividing them into the period of establishment of the union, approval of the project, application for sale, management disposal plan, removal and construction. Hong & Jeong (2018) completed the stage of planning to establish a basic plan and designate the zones for reconstruction of the zone, and the stage of project preparation, execution, and disposition to receive approval from the promotion committee.

In this study, the stages of reconstruction were divided into four phases based on prior studies, as shown in the [Figure 4] below. The stage from designation of the reconstruction zones to the construction design company selection was classified as 'Preparation Phase', which is ‘Stage 1’. In this phase, the possibility of reconstruction is determined, but not by a clear body such as a union. The second stage, the project execution phase, includes the stage from the approval of the union to the declaration of demolition. This step can get which conflicts within union members can occur, and therefore it can affect the perception of the expected reconstruction of nearby residents. It is also a period of migration for existing residents in reconstructed housing, which may affect the surrounding rent market. The third stage of completion of the project is a period of direct physical change in the housing reconstruction. The four-step move-in phase is when residents come back in before the reconstruction takes place and new tenants are created. In other words, there is an alternative to houses with less than 20 years of construction, which are seen as unlikely to be rebuilt. In the case of the rent market, it is a time when residents who have temporarily migrated due to reconstruction can suffer from a temporary oversupply.

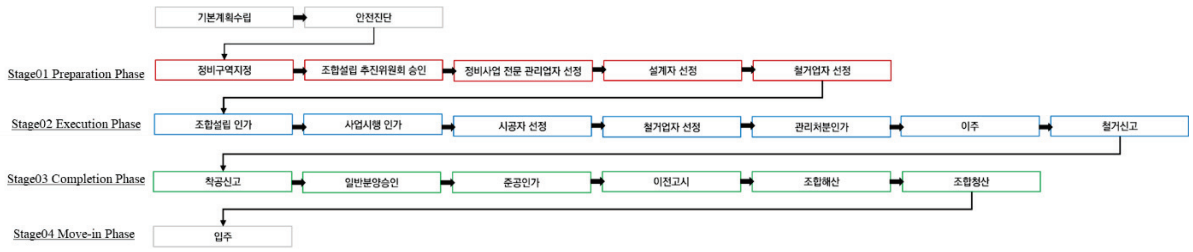

Figure 4. Operational definition about the phase of the housing reconstruction project

2.2 Spillover Effect

In the case of housing redevelopment, the Spillover Effect may not be only available for new housing but also as a residential market around the development area due to nearby environment improvements. Ha, S. K. (2004), analyzed the near-close changes that housing redevelopment projects bring about, in other words, defined housing development as a factor that ultimately improves the well-being and neighborhood of residents. In addition, residents expect a rise in wealth due to rising housing prices in the housing development project. That is, the increase in the quality of the housing will lead to an increase in housing prices. However, capital gains from these rising housing prices are limited to owners. These housing redevelopment projects contribute to the improvement of urban environment and increased housing inventory, explaining that all neighborhood plans eventually play a leading role in the community. In Imergluk, D. (2009) said that multi-purpose development has a positive ripple effect on housing values. Generally speaking, it is said to have a dramatic effect on the basis of 0.25 mile(400m). In the Liu, Y et al (2017), this paper pointed out that the impact of the development project on housing prices was taken for granted and rarely quantified. In other words, these development initiatives may exist considerably.

Of course, housing reconstruction is not a project involving infrastructure improvements such as redevelopment projects. However, a number of prior studies were conducted through the hypothesis that the price of apartments for reconstruction affected the price of regular apartments. Most of the time, the studies analyzed the relationship between price changes using the Grandeur causal analysis technique. According to Lee & Lee (2004), the Gangnam district has demonstrated the hypothesis that apartment prices will determine the neighborhood housing price of the average apartment using the Grandeur's causal test. Interpretation of these results could be seen as 'difference in price of information' or when a nearby house belongs to an apartment being rebuilt. (Seo, 2007) Lee (2004) may say that apartments with more than 15 to 20 years of age are compatible with the market's judgment on the possibility of reconstruction. So it can be seen as a reflection of the public's judgment that reconstruction will take place sometime in the future. As a result, it was defined that, from a long-term perspective, the price level of non-reconstruction apartments would be different from the price level of apartments that can be reconstructed. In other words, although there may be causal or correlation between short-term price changes, it is not clear that the price increase of apartments that can be rebuilt has led to price increases in the view of the long-term changes in price. Choi (2007) confirmed that real estate prices of apartments affected the prices of new apartments and indicated that new apartments were affecting the prices of apartments that could be rebuilt. Kim (2007) proposed a theoretical model of the spillover effects of reconstruction. If the positive externalities are greater than the negative externalities, the consumer surplus from housing

consumption will increase, leading to an increase in housing demand. In other words, the value of housing in the neighboring housing market is positive for capitalization. However, if the negative externalities are greater than the positive externalities, the qualitative decline in the surrounding residential services would negatively affect the housing price in the neighboring housing market.
In Ellen (2008), this research takes the effects of subsidized rental housing on neighborhoods in various ways. The first is the Physical Structure Effect. Attractive and high-quality new buildings can make neighborhoods well-maintained. The second is Removal Effect. The effect of changing a shabby building into a new building has the effect of improving the overall environment around it. The third is Market Effect. If any site in the neighborhood is well developed, the anxiety about profitability can be eliminated. The fourth is the Population effect. In general, the reconstruction volume is up-graded and the local infrastructure can be expanded due to the population increase. This spillover effect is used as an important study theory in this study.

Kim & Choi (2008) tried to substantiate their claim that "the price of apartments to be rebuilt in Gangnam, Seoul increases the price of apartments in the surrounding areas." In other words, housing prices have responded to market information first. However, the results of the study showed that there was no clear indication of the timing of the information transfer. In other words, the effect of price ripple effects on reconstruction and general apartments in Gangnam is not proven empirically. Jeon (2015) said as it affects the communities in which redevelopment and reconstruction projects are carried out, it is necessary to examine the ripple effects of the project in advance. According to Park & Choi (2015), this study said that there is a positive mutual effect between the sale and the lot-solid apartment and that there is an alternative relationship. In addition, the impact of the lot-solid apartment price is greater than the impact of the sale price, indicating that the policy to regulate the distribution of the sale price is less effective. Kim et al (2016) analyzed the effect of the spread of apartment prices using the actual price index in the apartment market, especially in Gangnam area, to demonstrate a trend that is perceived as having a significant impact on apartment markets in other areas. Hwang & Kim (2016) conducted an empirical analysis on whether the price increase of reconstructed apartments was the cause of the rise in the prices of general apartments. As a result of reviewing the long-term clockwork of housing prices, the price volatility of the reconstructed apartment was higher than that of the average apartment price. In other words, the myth that the price increase of apartments for reconstruction causes an increase in the price of apartments for non-residential buildings is not true.

In this study, it is meaningful to analyze the Spillover Effect of Housing Reconstruction empirically. In particular, prior studies related to this object have analyzed causal relationships through analysis of the factors and relationships of the Grandeur to see the Spillover Effect of Reconstruction. However, this is not necessarily an indication of the effect on causality, but a way of showing trends. In this study, the Hedonic model was used to variable the stage of the reconstruction

process assuming that it was one of the factors that affected housing prices.

2.3 Expectation of Reconstruction due to Information Acquisition in the Housing Market

In the previous study on the Spillover Effect, this study can see that housing reconstruction can affect the price of surrounding houses. With the progress of surrounding housing reconstruction well underway, apartments with potential for reconstruction may also serve to remove uncertainty about the possible progress of reconstruction. In general, prior studies have shown that the old year has an impact on the expected value of possible reconstruction. According to Kim & Lee (2005), the expectation of a housing service level decline and reconstruction is applied in a combination according to the old year. In addition, the volume ratio has a negative relationship with apartment prices, which means that the lower the volume ratio, the higher the realizable capital gain from the reconstruction, the higher the expectation of reconstruction. According to Seo (2017), the effects of expected reconstruction effects on apartment prices were analyzed in a time series. It was proposed in 17.38 years that the expected effect of reconstruction would be felt. This point is similar to 20 years or 25 years when the expected effects of reconstruction were shown through Lee & Shin 2001; Choi & Gong, 2003. Through the preceding studies, the market for apartment housing is largely divided into the ongoing reconstruction of apartments, apartments with the potential for reconstruction due to the old age, and general apartments with a low construction age.

In this market classification situation, residents living in apartments with potential for reconstruction can take advantage of the elimination of uncertainty through apartments under reconstruction. First, Clapp, J. M. et al (1995) point out that investors lack information regardless of housing or securities. In these circumstances, rational consumption is used to obtain information and to balance costs and benefits. In this situation, price data is generally considered the easiest and most accessible information. That is, many investors are affected by the investment behavior of people by Lagged price changes. That is, people form an investment value based on information about the surrounding real estate market. Han & Lee (2009) analyzed the trend of selling houses, saying, "The housing prices have increased due to the expansion of expectations for reconstruction." Kim (2015) analyzed the factors affecting whether Seoul's housing redevelopment and reconstruction projects continue or end. In particular, we have seen how trust with our neighbors has affected the project, and the result is that it does not affect the project.

In the preceding study, the possibility of such reconstruction and the possibility of nearby reconstruction were not seen in the nearby units, but the analysis was conducted in the city and county units. Based on prior study, this research divided the transaction of apartments 20 years older than the transaction period at the time of transaction and the transaction of apartments less than 20 years old.

2.4 The physical change effect by reconstruction apartment site

When reconstruction is under way, the biggest physical changes are the demolition, migration, and move-in periods. In particular, there is a combination of the market for rent and sale during migration and relocation. At this point, the situation is to move out of the reconstructed apartment, which the preceding study suggests could change the price of the surrounding housing market from two months ago. Lee (2002) interpreted the effects of the reconstruction as an additional factor of increase in apartment rental markets and that non-household type housing supply would play a role in the fall of the local rental prices. Choi et al (2004) conducted an case study on the changes in the price in neighboring areas due to reconstruction projects. There was a tendency to migrate to Songpa-gu, the neighboring districts of Gangdong-gu and Gangnam-gu, which are generally identical. It can also be seen that the price of rent has risen sharply, one to two months earlier than the time of migration in May 2002. In other words, temporary increases in housing demand have revealed local and short-term effects on the rise in chartered prices. Glaeser et al(2006) studied that the empirical results demonstrate that the fundamental connection between urban change and the housing stock is clearly evident in the strong correlation between population levels and housing units. In Seong & Park (2014), It revealed the impact of the houses on the former and the sale prices, the latter on the negative effects of the former prices, and the volume of the sale prices. However, the research is limited by analyzing the Seoul metropolitan area and seeing the supply of reconstruction as of August 2013. Jeon et al (2015) said that When a house is destroyed on a large scale after administrative disposition, there is a sudden increase in the amount of rent demand in the surrounding area. Subsequently, the issue was raised as a problem that Inverse rental houses are being created due to the large new housing supply. Jee et al (2017) analyzed the correlation between an increase in the number of houses that are destroyed and changes in the price of rent deposits. A 1% increase in the volume of destroyed goods has been shown to raise the price of war to 26.5% in the region before the third quarter. Therefore, it was necessary to predict the ripple effect on the rent price and adjust the timing of the reconstruction project. Kim (2017) analyzed the trend of apartment prices following migration based on the case of reconstruction of Godeok Apartment. The migration demand for apartment reconstruction affected the housing market in the short-term region for two to three months, but since then, it has shown that it has stabilized. In this study, case studies were mainly conducted for the duration of population movement. The limit of these case studies is that several apartment complexes in the housing market cannot generalize and reveal their relationships with each other.

Therefore, this study analyzes both the time of migration and the time to move in and to report how the sale and rent market are affected by population movement as housing reconstruction progresses. At the time of migration, residents living in reconstructed houses move around. Therefore,

the rent market is expected to be affected by positive influence. Also, at the time of moving in, it is expected that a small apartment under 20 years of construction will be negatively affected by the emergence of replacement goods. Rent markets are also expected to be affected by the purchase of new apartments by temporary residents.

2.5 Housing Filtering Theory

Filtering Theory in the housing market shows how housing changes in terms of quality and residents' income over time. According to Filtering Theory, it can be interpreted as the Filtering Down phenomenon leading to low-income households and the Upward Mobility phenomenon where the quality of houses improves. Filtering in the housing market means that when new homes are supplied to the higher income, existing inventory houses will be put down, improving the housing quality at all levels. (Olsen, E. O., 1969) According to O'Sullivan, A., & Gibb, K. (Eds.). (2008), the amount of housing services created by housing is lost as they are physically degraded and depreciated. In other words, housing moves downward on the quality ladder. Then, existing homes, not new ones, will be owned by households with low incomes. Hong & Ahn (2011) said, "The Filtering Theory has great difficulties in owning self-ownership of people under the middle class." It also noted that a policy to provide housing in areas close to existing dwellings is necessary. Lee& Choi (2012) noted that as the physical aging and functional deterioration progresses, the price of old apartments could rise to reflect the expected levels that could be provided after reconstruction. The study found that the selling price of new apartments was 1.5 times higher than that of used apartments, and the cause can be understood as a result of the physical aging of used apartments and the deterioration of their functionality. The difference in prices between the two was not be in long-term, but indicated the need for access through the market price stabilization process. In Cha et al (2015), the effect of supplying new houses was considered based on whether filtering was occurring in each of the sub-market. In other words, it is possible by comparing the value of a house in which it is occupied and one before it was moved. It can be said that housing prices have risen due to the supply of new houses, resulting in filtering of houses.

Of course, this paper does not analyze whether the Filtering theory works well in the housing market. However, if the Filtering theory is doing well, reconstruction in the moving stage will result in the new housing being supplied to the high-income, and the possibility of low-income families moving into the existing better apartments' values will increase. In this study, the price of more than 20 years aged housing is not reduced to allow low-income people to buy houses, but rather because the investment value is maximized, the Filtering Theory may not be well established. In this study, it would like to report whether more than 20 years aged housing prices undergo price changes based on such logic like this.

III. Research Design

3.1 Research scope and procedure

Spatial Scope

The geographical scope of the study is Songpa-gu, Seoul. First of all, Gangnam area is a place where the economy and private education are doing well, plus especially due to recent reconstruction potential. (Park & Jang, 2016) In the preceding research paper, three districts (Seocho-gu, Gangnam-gu, and Songpa-gu) were designated and explained as a residential area for the upper class. (Lee & Seo, 2009; Kim & Choi, 2015) In particular, the area of Songpa-gu is where Jamsil reconstruction of 1, 2, 3 and 4 complex areas have already been completed and the reconstruction process continues. This study would to see how the surroundings are affected by the total of 24 reconstruction complexes presented below. [Table 1] below lists 24 housing reconstruction sites through Seoul Open Data Website, Songpa-gu Website, and clean-up system in Seoul Website.

Num	Reconstruction Project Site Name	Area Size (㎡)
1	삼환가락아파트 주택재건축정비사업	40,789
2	가락극동아파트 주택재건축정비사업	40,112
3	가락프라자아파트 주택재건축정비사업	47,807
4	가락시영아파트 주택재건축정비구역	405,782
5	가락1차현대아파트 주택재건축정비사업	33,953
6	문정동 136일대 주택재건축정비사업	64,975
7	송파동 100번지 주택재건축정비사업	24,925
8	송파한양2차아파트 주택재건축정비사업	56,314
9	가락삼익맨숀 주택재건축정비사업	62,059
10	송파동 반도아파트 주택재건축정비사업	30,092
11	장미123차아파트 주택재건축정비사업	343,267
12	잠실미성크로바아파트 주택재건축정비사업	72,802
13	잠실진주아파트 주택재건축정비사업	112,559
14	오금동 143 주택재건축정비사업	14,180
15	가락상아1차아파트 재건축정비사업	13,580
16	잠실주공5단지주택재건축정비사업	353,988
17	우성아파트 주택재건축정비사업구역	120,354
18	잠실우성4차아파트 주택재건축정비사업	31,631

19	풍납우성아파트 주택재건축정비사업	21,722
20	이화연립 주택재건축정비사업	2,535
21	잠실1단지 주택재건축정비사업	231,604
22	잠실2단지 주택재건축정비사업	322,472
23	잠실3단지 주택재건축정비사업	209,160
24	잠실4단지 주택재건축정비사업	157,873

Table 1. List of reconstruction projects in Songpa-gu, Seoul

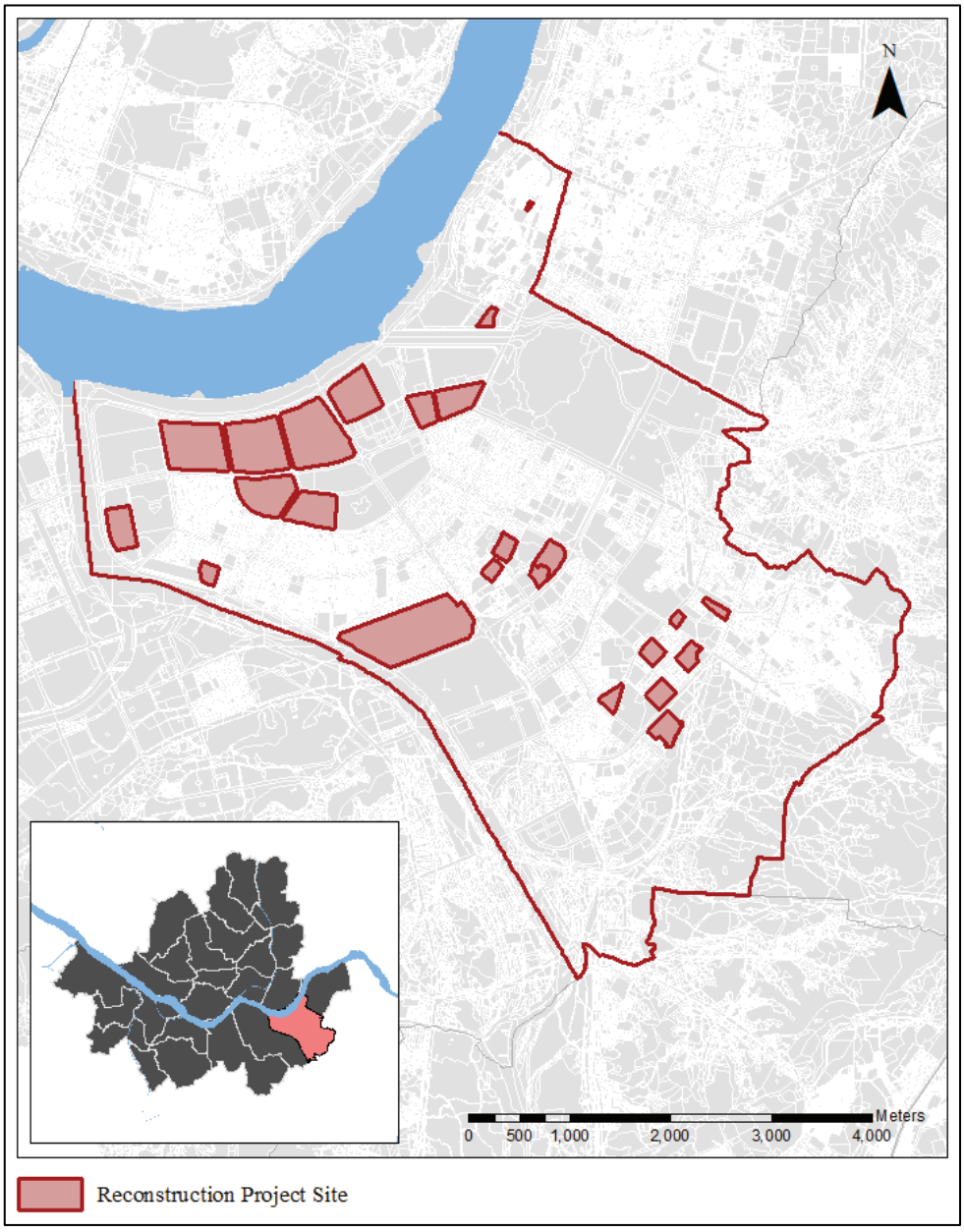

Figure 5. Location of Reconstruction Projects in Songpa-gu, Seoul

Temporary Scope

The actual transaction of apartments by the Ministry of Land, Infrastructure, and Transport's data. First, the sale market designated the research scope from January 2006 to June 2018 when the actual transaction was recorded. Depending on the age of housing construction, the possibility of reconstruction can be checked. According to the Urban and Residential Environment Improvement Act, buildings that have passed the age from 20 years to 30 years after completion of construction are designated as aged or poor buildings. Therefore, this study analyzes the possibility of reconstruction by dividing it into 20 years of construction at the time of transaction. In the case of the rent market, the scope of the study was designated from January 2011 to June 2018 when the actual transaction of the Ministry of Land, Infrastructure, and Transport data was recorded.

Unit of analysis

The study analyzed the actual transaction price of the Department of Land, Infrastructure and Transport 55,919 sale transactions (2006.01 – 2018.06) and 102,522 rent transactions (20011.01 – 2018.06). A total of 426 units were in sale market and 439 were traded in rent market. This study was based on a piece of a land registration map, not the point data of geocoding.

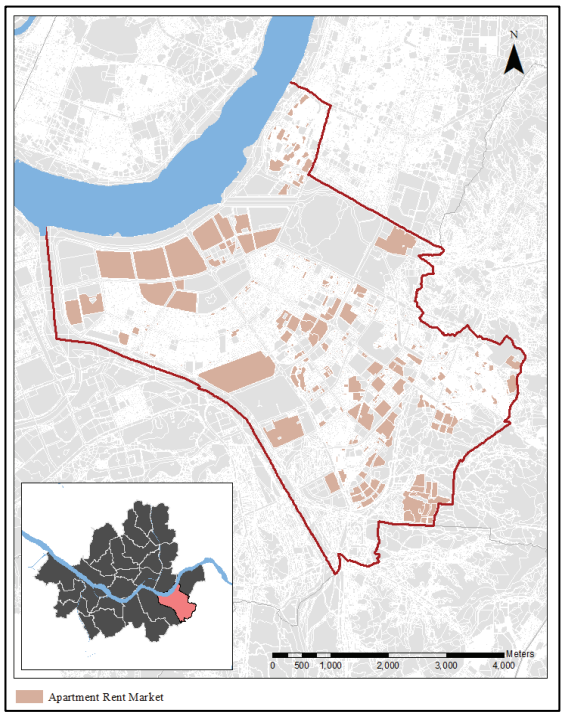

Figure 6. Apartment rent market transactions

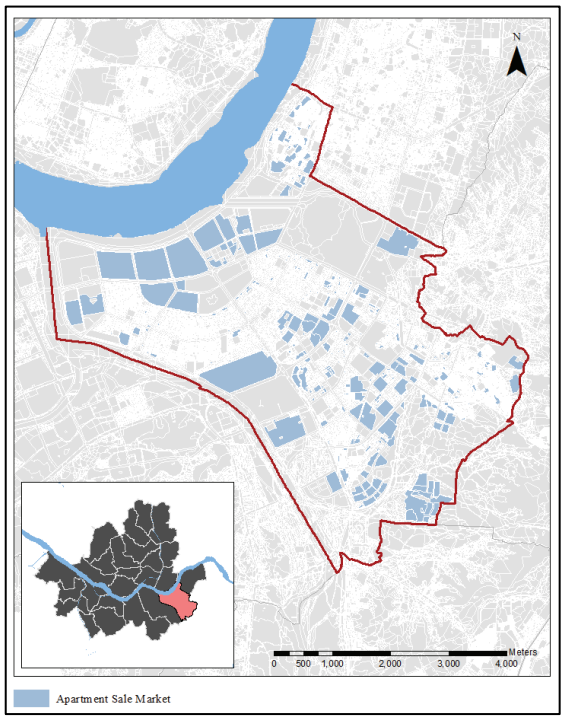

Figure 7. Apartment sale market transactions

3.2 Data and Variable Operation

Dependent variable

This study is based on the Hedonic model, which looks at the impact on housing prices. A dependent variable is the housing price of each transaction. Prices were made to satisfy the normality assumption through log transformation. The selling price was converted into a log of the prices recorded by the Ministry of Land, Infrastructure and Transport. In Korea case, there is a Jeonse(전세) system that have a deposit and a monthly rent. By utilizing the conversion rate (2011.01-2018.06) provided by the Korea Appraisal Board, the deposit was converted to monthly rent in the case of rental prices. In case of monthly rent, the deposit was converted to monthly rent price using the conversion rate of the previous month and the price was converted by adding the existing monthly rent price. Therefore, the converted price was used as a dependent variable through this process.

Independent Variable

a. Reconstruction Characteristic

This study analyzes how the progress of the reconstruction complex affects the prices of surrounding apartments. In other words, there is a need to define the stages of reconstruction process. Prior to that, there is a need to define the area in which reconstruction is underway. In this study, based on the site of the reconstruction site, a 400m buffer and an 800m buffer were used to define the proxies. In addition, based on the earlier classification of the reconstruction process, the Stage was divided and analyzed as shown in [Table 2] below.

Definition	Explanation
Stage01	정비구역 지정 ~ 설계자 선정
Stage02	조합설립 인가 ~ 철거 신고
Stage03	착공신고 ~ 조합청산
Stage04	입주

Table 2. Operational definition about the housing reconstruction project process

The above definition of reconstruction phase and the construction progress complex are combined to show that each business site is progressing, as shown in [Table 3] below. Twenty-four complexes are already conclued by six units.

Num	Stage01	Stage02	Stage03	Stage04	Reconstruction Project Site Name
1	2017.11				삼환가락아파트 주택재건축정비사업
2	2017.11				가락극동아파트 주택재건축정비사업
3	2016.12				가락프라자아파트 주택재건축정비사업
4	2012.08	201412	201504		가락시영아파트 주택재건축정비구역
5	2017.11				가락1차현대아파트 주택재건축정비사업
6	2015.01	201605			문정동 136일대 주택재건축정비사업
7	2014.06				송파동 100번지 주택재건축정비사업
8	2010.06				송파한양2차아파트 주택재건축정비사업
9	2017.09				가락삼익맨숀 주택재건축정비사업
10	2005.11	200706	200811	201201	송파동 반도아파트 주택재건축정비사업
11	2005.12				장미123차아파트 주택재건축정비사업
12	2005.12	201406			잠실미성크로바아파트 주택재건축정비사업
13	2005.12	201505			잠실진주아파트 주택재건축정비사업
14	2014.09				오금동 143 주택재건축정비사업
15	2017.12				가락상아1차아파트 재건축정비사업
16	2005.12	201311			잠실주공5단지주택재건축정비사업
17	2015.12				우성아파트 주택재건축정비사업구역
18	2017.07	201804			잠실우성4차아파트 주택재건축정비사업
19	2005.12	2009.12	201510		풍납우성아파트 주택재건축정비사업
20	2006.01	2006.08	201011	201011	이화연립 주택재건축정비사업
21	2000.09	2001.09	2005.05	200809	잠실1단지 주택재건축정비사업
22	2000.09	2001.01	2005.02	200807	잠실2단지 주택재건축정비사업
23	2000.09	2000.12	2004.05	200708	잠실3단지 주택재건축정비사업
24	2000.09	2000.12	2004.02	200612	잠실4단지 주택재건축정비사업

Table 3. Status of Reconstruction Apartment in Songpa-gu, Seoul

Thus, in this study, a dummy variable was assigned to a traded housing within the 400m and 800m buffer, depending on the date of the process during reconstruction. Also, the housing reconstruction project at 100 Songpa-dong, number 7, was cancelled as of January 2018, and the housing reconstruction project at 143 Ogeum-dong, number 14, was canceled as of July 2018. It was designated as a variable to reflect the information on the revocation of reconstruction within the scope of the study. In addition, it is designated as a reconstruction complex, and price changes occur as a result of an increase in asset values during the project. To control the effects of these changes, 'Self Reconstruction' was designated as a dummy variable in the transaction history under reconstruction.

b. Physical, Locational, and Transaction Characteristic

In this study, it used a multilevel model based on the Hedonic model. Therefore, control over the physical housing characteristics of individual houses is necessary. First, the individual housing

size, number of floors, and building age at the time of the transaction were controlled. In addition, the large characteristics of the complex were controlled by dummy variables based on 500 households. Also it found the closest street to an elementary school, subway station, and street from the entrance to the Han River based on the geographical characteristics of the apartment traded. Afterwards, the dummy variables were controlled on a 400m like walkable distance. In the case of Wirye-dong, Songpa-gu, the "New Town of Wirye" has been under development since January 2008. Thus, from January 2008, the transaction in Wirye-dong was controlled by adding dummy variables. Transactions can vary with season and may have an impact on price changes depending on economic growth. The transaction year/ month was entered as a dummy variable.

3.3 Analytical methods

The hierarchical linear model was used in this study. According to Rosen (1974), the Hedonic Model was able to estimate house prices from their sum based on the potential prices of individual features such as structures and locations that constitute a house.

$$P_i = aX_i + \sum \beta_i S_{ki} + \sum \gamma_q L_{qi} + \varepsilon X_i$$

$P_i = Housing\ Price$, S_{ki}, L_{qi} = Physical and Locational characteristics of housing, $\varepsilon X_i = Error\ term$

However, estimates of housing prices using these hedonic models have problems. First, there is no consideration for the local characteristics of housing. In addition, using cross section data can cause problems of self-correlation and spatial separation. Therefore, these problems may not be considered in the Hedonic Model by considering the structural effects and the Contextual effects of housing that characterize housing location. (Kim, 2003) To overcome these problems, there is a need for hierarchical linear model (multi-level model). Thus, a hierarchical linear model was applied to control the effects of unobservant variables and to minimize the impact of spatial heterogeneity.

Housing is usually treated as a foreign commodity because the characteristics of housing are indivisible and are traded in bundles. (Marco Helbich et al, 2014) Although the price function assumes the space balance between demand and supply of residential characteristics, supply is largely inelastic, because the property is fixed in space and the durability and consistent characteristics. (Malpezzi, 2003). This model divides the potential impact of housing prices into the hierarchical forces of individual levels and apartment complexes. That is, it is necessary to understand the effects of interaction between the descriptive variables at the higher level and the descriptive variables at the individual levels.

[Level – 1 Model]

$$P_{ij} = \beta_{0i} + \sum \beta_{kj} X_{kij} + \gamma_{ij}$$

P_{ij} = i Housing Price in j Apartment complex
X_{qij} = qth independent variable of j Apartment complex i House
β_{0j} = Interxept of j Apartment complex
β_{qj} = Regression coefficient of X_q in j Apartment complex
γ_{ij} = Random error of i house in j Apartment complex

[Level – 2 Model]

$$\beta_{qi} = \gamma_{q0} + \sum \gamma_{qs0} W_{qj} + u_{qj}$$

β_{qj} = representing the slope of the independent variable regression coefficient
W_{sj} = sth Apartment of j Apartment complex characteristic variable
γ_{q0} = Intercept of Level-1 Model
γ_{qs} = Regression coefficient of W_s variable
u_{qj} = Random error of j Apartment complex

Therefore, this study analyzed the impact of individual characteristics of apartment units, the characteristics of the apartment complex and the progress of nearby reconstruction on apartment prices. Residual analysis to determine linearity of this model should be preceded by the analysis of the residuals. (Kim & Ahn, 2010) Multicollinearity between independent variables was verified through the VIF values, and all variables were less than 5 and hence no problems. The normality of the dependent variable distribution did not have to be statistical verification of more than 500,000 samples in the scope of the study. In addition, it is required to determine whether differences between groups of dependent variables are significant and to determine the applicability of the multistory model through ICC (inter-group correlation). In this study, ICC is appropriate to use a hierarchy model from 67 to 90. A random sample model was applied that does not estimate the random effect of a separate characteristic variable at a higher level and gives only the simplest form of random intercept. Conceptually, it can be seen that the higher levels of discretion reflect the characteristics of individual dwellings, such as unobserved or undetected spatial characteristics or remodeling, that are not measured by independent variables at lower levels.

$$ICC = p = \frac{\tau}{\tau + \sigma^2} \times 100\%$$

τ = Variance betwwen Apartment Complex
σ^2 = Variance in Apartment Complex

IV. Results

4.1 Description statistics

This study proposes a model that relates to the sale of apartments for more than 20 years, the sale of apartments for less than 20 years, and the rents of apartment. In addition, the independent variables were added by dividing the properties related to reconstruction into 400m and 800m buffers based on the site where reconstruction is being performed with three housing market model. That is, there are six models of analysis.

First, there are three models that set the right to re-build within 400 meters based on the site where reconstruction takes place. The basic statistics relating to apartment sales transactions over 20 building years are as shown in [Table 4] The housing price, a dependent variable, was used for the value obtained through the log transformation. There are five physical characteristics of an independent variable. It includes the size of the housing, the number of floors, the household of the complex, and the building age at the time of the transaction. The location variable was designated as a dummy variable for elementary schools and subway stations within 400 meters. In other models, the distance from the main entrance of the Han River was designated as a dummy variable within 400 meters. However, the model excluded dummy variables at the entrance to the Han River within 400 meters. This data is based on the actual transaction price of the Department of Land, Infrastructure and Transport from January 2006 to January 2006. The entrance to the Han River within 400 meters is related to Jamsil-gu. In January 2006, the area around the main entrance of the building was not recorded at the time of the demolition. In other words, the complex corresponding to the entrance to the Han River within 400 meters is not captured in this data. Therefore, this model is excluded. Further, the new urban development area in Wirye-dong was controlled by adding a dummy variable as of January 2008, when selected as the urban development zone.

In this study, it is essential to see the role of variables related to reconstruction. Within 400m of the buffer against the housing reconstruction complexes, the study adds a dummy variable to the transaction details that were traded at each point in time to see the effect of reconstruction on the surrounding areas by stages. Also, if the apartment complex itself is a reconstruction progress complex, it was transformed into a self-construction variable, and 23% of the transaction history is undergoing reconstruction. And housing prices are affected by macroeconomic variables, economic growth and external environmental factors related to housing policy. These changes were controlled by dummy modulation of the transaction year and month. From January 2006 to June 2018, the model added dummy variables each time.

	Variable	Obs.	Mean	Std.Dev.	Min	Max
Dependent Variable						
	LN Price	23,456	11.068	0.467	9.547	12.707
Independent Variable						
Physical Characteristics	Size	23,456	81.989	31.160	23.430	253.590
	Floor	23,456	7.338	4.646	1.000	29.000
	FAR	23,456	209.350	77.704	45.000	921.000
	Building age	23,456	28.230	5.321	20.000	40.000
	Household (over 500)	23,456	0.794	0.404	0.000	1.000
Locational Characteristics	Elementary 400m	23,456	0.730	0.444	0.000	1.000
	Subway 400m	23,456	0.465	0.499	0.000	1.000
	Wirye-dong (From. 200801)	23,456	0.002	0.041	0.000	1.000
Reconstruction Characteristics	Stage01 (400m)	23,456	0.198	0.399	0.000	1.000
	Stage02 (400m)	23,456	0.070	0.255	0.000	1.000
	Stage03 (400m)	23,456	0.032	0.176	0.000	1.000
	Stage04 (400m)	23,456	0.000	0.017	0.000	1.000
	Self-Reconstruction	23,456	0.234	0.423	0.000	1.000
Transaction Characteristics	2006.01 – 2018.06	23,456				

Table 4. Descriptive statistics of the variables in the sale market (over than 20years/ 400m buffer)

Second, the basic statistics relating to apartment sales transactions less than 20 years are as shown in [Table 5]. The remaining variables are as shown above. In this model the Self Reconstruction variable is 0. This model is an analysis of transactions with a construction period of less than 20 years, which is not included in the building age, and therefore cannot include the complex under reconstruction.

	Variable	Obs.	Mean	Std.Dev.	Min	Max
Dependent Variable						
	LN Price	32,463	10.984	0.524	8.517	12.897
Independent Variable						
Physical Characteristics	Size	32,463	79.674	27.887	12.900	254.420
	Floor	32,463	11.131	7.511	1.000	46.000
	FAR	32,463	300.675	112.415	45.000	1062.649
	Building age	32,463	9.885	4.718	1.000	19.000
	Household (over 500)	32,463	0.660	0.474	0.000	1.000
Locational Characteristics	Elementary 400m	32,463	0.788	0.409	0.000	1.000
	Subway 400m	32,463	0.378	0.485	0.000	1.000
	Hanriver Entrance 400m	32,463	0.099	0.299	0.000	1.000
	Wirye-dong (From. 200801)	32,463	0.001	0.034	0.000	1.000
Reconstruction Characteristics	Stage01 (400m)	32,463	0.110	0.313	0.000	1.000
	Stage02 (400m)	32,463	0.081	0.273	0.000	1.000
	Stage03 (400m)	32,463	0.007	0.081	0.000	1.000
	Stage04 (400m)	32,463	0.013	0.115	0.000	1.000
	Self-Reconstruction	32,463	0.000	0.000	0.000	0.000
Transaction Characteristics	2006.01 – 2018.06	32,463				

Table 5. Descriptive statistics of the variables in the sale market (less than 20years/ 400m buffer)

Third, the basic statistics relating to apartment rent transactions are shown in [Table 6]. The remaining variables are as shown above. Unlike the preceding sale, it was conducted as a model without dividing into building year. The transaction types are divided into jeonse and monthly rents. Of course, prices were converted using the conversion rate, but to reflect the difference between the transaction method, a dummy variable separating the jeonse and monthly rent was added. According to the results, the monthly rent is 26.9 percent and the jeonse is 73.1 percent. And unlike sales, data related to the rent are from January 2011 to June 2018 when the Ministry of Land, Infrastructure and Transport began providing data. Thus, the dummy variables for time were controlled by time variables. Also, the 'Self Reconstruction' variable was carried out in two groups. In Stage 01 the site for reconstruction, in Stage 2 it was expected that the effect on the price of a reconstruction complex would be different.

	Variables	Obs.	Mean	Std.Dev.	Min	Max
Dependent Variable						
	LN Price	102,522	5.026	0.463	2.166	7.204
Independent Variable						
Physical Characteristics	Size	102,522	81.408	27.686	12.896	254.420
	Floor	102,522	10.090	7.041	1.000	46.000
	FAR	102,522	258.966	99.872	45.000	1063.000
	Building age	102,522	17.901	11.523	1.000	41.000
	Household (over 500)	102,522	0.781	0.413	0.000	1.000
Locational Characteristics	Elementary 400m	102,522	0.773	0.419	0.000	1.000
	Subway 400m	102,522	0.403	0.491	0.000	1.000
	Hanriver Entrance 400m	102,522	0.067	0.250	0.000	1.000
	Wirye-dong (From. 200801)	102,522	0.016	0.125	0.000	1.000
Reconstruction Characteristics	Stage01 (400m)	102,522	0.172	0.378	0.000	1.000
	Stage02 (400m)	102,522	0.103	0.304	0.000	1.000
	Stage03 (400m)	102,522	0.006	0.078	0.000	1.000
	Stage04 (400m)	102,522	0.001	0.038	0.000	1.000
	Stage 01: Self-Reconstruction	102,522	0.087	0.281	0.000	1.000
	Stage 02: Self-Reconstruction	102,522	0.051	0.220	0.000	1.000
Transaction Characteristics	Transaction type (Monthly rent = 1)	102,522	0.269	0.443	0.000	1.000
	2011.01 – 2018.06	102,522				

Table 6. Descriptive statistics of the variables in the rent market (400m buffer)

The previous basic statistics are on the right of re-building within 400 meters based on the site where reconstruction takes place. As you can see from the basic statistics above, Songpa-gu consists of about 70 percent of apartments complex consisting of 500 or more households. In other words, it may not be appropriate to view a 400m buffer designated as the zone of influence as the size that covers a single jar. Therefore, it is necessary to set the surrounding influence on the basis of the 800m buffer to see the impact of reconstruction.

In other words, the basic statistics presented from now on are three models that set the right to rebuild within 800 meters based on the site where reconstruction is being undertaken. Fourth, the basic statistics relating to the sale of apartments for more than 20 years are as shown in [Table 7]. Variables related to reconstruction are not enough to sample stage 04 if they are viewed within 800 meters of a buffer based on housing reconstruction complexes. Most of the apartment complexes in Songpa-gu area were built in January 2006. In this study, 'Stage04 move in' variable was modified by including the details of transactions made more than a year from the date of starting 'move in'.

	Variable	Obs.	Mean	Std.Dev.	Min	Max
Dependent Variable						
	LN Price	23,456	11.068	0.467	9.547	12.707
Independent Variable						
Physical Characteristics	Size	23,456	81.989	31.160	23.430	253.590
	Floor	23,456	7.338	4.646	1.000	29.000
	FAR	23,456	209.350	77.704	45.000	921.000
	Building age	23,456	28.230	5.321	20.000	40.000
	Household (over 500)	23,456	0.794	0.404	0.000	1.000
Locational Characteristics	Elementary 400m	23,456	0.730	0.444	0.000	1.000
	Subway 400m	23,456	0.465	0.499	0.000	1.000
	Wirye-dong (From. 200801)	23,456	0.002	0.041	0.000	1.000
Reconstruction Characteristics	Stage01 (800m)	23,456	0.298	0.457	0.000	1.000
	Stage02 (800m)	23,456	0.047	0.211	0.000	1.000
	Stage03 (800m)	23,456	0.072	0.258	0.000	1.000
	Stage04 (800m)	23,456	0.000	0.020	0.000	1.000
	Self-Reconstruction	23,456	0.234	0.423	0.000	1.000
Transaction Characteristics	2006.01 – 2018.06	23,456				

Table 7. Descriptive statistics of the variables in the sale market (over than 20years/ 800m buffer)

Fifth, the statistics relating to the sale of apartments less than 20 years are as shown in [Table 8] As with the 400m impact zone above, the Self Reconstruction variable is 0. This model is not included in the building age of less than 20 years and therefore does not include the complex under which reconstruction is underway.

	Variable	Obs.	Mean	Std.Dev.	Min	Max
Dependent Variable						
	LN Price	32,463	10.984	0.524	8.517	12.897
Independent Variable						
Physical Characteristics	Size	32,463	79.674	27.887	12.900	254.420
	Floor	32,463	11.131	7.511	1.000	46.000
	FAR	32,463	300.675	112.415	45.000	1062.649
	Building age	32,463	9.885	4.718	1.000	19.000
	Household (over 500)	32,463	0.660	0.474	0.000	1.000
Locational Characteristics	Elementary 400m	32,463	0.788	0.409	0.000	1.000
	Subway 400m	32,463	0.378	0.485	0.000	1.000

	Hanriver Entrance 400m	32,463	0.073	0.260	0.000	1.000
	Wirye-dong (From. 200801)	32,463	0.001	0.034	0.000	1.000
Reconstruction Characteristics	Stage01 (800m)	32,463	0.307	0.461	0.000	1.000
	Stage02 (800m)	32,463	0.150	0.357	0.000	1.000
	Stage03 (800m)	32,463	0.026	0.158	0.000	1.000
	Stage04 (800m)	32,463	0.008	0.087	0.000	1.000
	Self-Reconstruction	32,463	0.000	0.000	0.000	0.000
Transaction Characteristics	200601 – 201806	32,463				

Table 8. Descriptive statistics of the variables in the sale market (less than 20years/ 800m buffer)

The sixth basic statistic is shown in [Table 9] in relation to the transaction of apartment rents. In particular, the average is smaller for the right to rebuild than for sale. The construction of a large-scale reconstruction in Songpa-gu was before the Ministry of Land, Infrastructure and Transport recorded the actual monthly rent. In other words, the market for rent contains less time range than the market for sale, which describes the scope of the reconstruction zone.

	Variables	Obs.	Mean	Std.Dev.	Min	Max
Dependent Variable						
	LN Price	102,522	5.026	0.463	2.166	7.204
Independent Variable						
Physical Characteristics	Size	102,522	81.408	27.686	12.896	254.420
	Floor	102,522	10.090	7.041	1.000	46.000
	FAR	102,522	258.966	99.872	45.000	1063.000
	Building age	102,522	17.901	11.523	1.000	41.000
	Household (over 500)	102,522	0.781	0.413	0.000	1.000
Locational Characteristics	Elementary 400m	102,522	0.773	0.419	0.000	1.000
	Subway 400m	102,522	0.403	0.491	0.000	1.000
	Hanriver Entrance 400m	102,522	0.067	0.250	0.000	1.000
	Wirye-dong (From. 200801)	102,522	0.016	0.125	0.000	1.000
Reconstruction Characteristics	Stage01 (800m)	102,522	0.347	0.476	0.000	1.000
	Stage02 (800m)	102,522	0.126	0.331	0.000	1.000
	Stage03 (800m)	102,522	0.029	0.168	0.000	1.000
	Stage04 (800m)	102,522	0.002	0.046	0.000	1.000
	Stage 01: Self-Reconstruction	102,522	0.140	0.347	0.000	1.000
	Stage 02: Self-Reconstruction	102,522	0.128	0.334	0.000	1.000
Transaction Characteristics	Transaction type (Monthly rent = 1)	102,522	0.269	0.443	0.000	1.000
	201101 – 201806	102,522				

Table 9. Descriptive statistics of the variables in the rent market (800m buffer)

4.2 Determinants of Apartment Sale Prices over 20 Years of Construction

Estimates of the housing price model for the impact of nearby home reconstruction are shown in [Table 10], result of sale market over than 20 years of housing. Model 1 gives an estimate of the random intercept model, including the dummy variables, with an impact zone of 400 meters for surrounding housing reconstruction. Model 2 specifies the scope of the impact zone for nearby housing reconstruction to be 800m, resulting in the derivation of the dummy to estimate the random intercept model. Model 1 and model 2 have an Intra-class Correlation Coefficient (ICC) value of 0.834 and 0.831, which means that the application of a hierarchical linear model is appropriate. Explanation ability of Model 1 and Model 2 is about 69% and 61% respectively. In addition, the results of the VIF analysis are not more than 5 and since there is no tendency in the residual graph, the analysis has been validated.

		Sale over than 20 years of housing	
	Variables	Model 1 (400m buffer)	Model 2 (800m buffer)
Physical Characteristics	Size	0.008***	0.008***
	Floor	0.002***	0.002***
	FAR	0.000	0.000
	Building age	0.027***	0.028***
	Household (over 500)	0.268***	0.258***
Locational Characteristics	Elementary 400m	0.063	0.056
	Subway 400m	0.032	0.038
	Hanriver Entrance 400m	omitted	omitted
	Wirye-dong (From. 200801)	0.062***	omitted
Reconstruction Characteristics	Stage01	0.021***	-0.003
	Stage02	0.090***	0.058***
	Stage03	0.061***	0.042***
	Stage04	0.106***	0.002
	Self-Reconstruction	0.049***	0.064***
Transaction Characteristics	2006.01 – 2018.06000	Included	Included
Intercept		9.341***	9.324***
Number of obs. / groups		23456 / 120	23456 / 120
Adj. R^2		0.691	0.689
ICC		0.834	0.831
AIC		-42928.29	-42707.13
BIC		-41597.91	-41384.81

Significant codes: 0.001 '***' 0.01 '**' 0.05 '*'

Table 10. Result of Sale market over than 20 years of housing

First, looking at the physical characteristics of Model 1, when size increases by 1%, apartment prices increase by 0.8%. When the floor variable is also increased by 1%, apartment prices increase by about 0.2%. Also, if you look at the dummy variable value of whether the household size

of the apartment complex is large, apartment prices will be high by about 26.8 percent. In summary, the larger the apartment size, the higher the number of floors, the more expensive the larger the price, showing a similar result value to the preceding studies. However, the physical property variable, the building age, is more than 1% older, and the apartment price increases by 2.7%. In general, buildings are depreciated as they get older, and prices generally fall. However, the model analyzed over 20 years of apartments, so it was shown through this variable that the higher the building envelope, the more likely it is to be rebuilt. Based on the location characteristics of Model 1, an elementary school or subway station within 400 meters may positively affect the price of an apartment, but it is not statistically significant. In addition, since January 2008, the new city has been under way in the Wirye-dong area, and the coefficient of the dummy variable indicates that the price will be about 6.2 percent higher if the city is in operation.

Based on the 400m effect housing reconstruction of Model 1, the coefficient of the Stage 01 variable indicates that the price of the area within 400m is about 2%. This step is when the repair area is designated and the designer company is selected. The reason for the volume impact is that the surrounding housing market could also see a slight rise as the government sees the possibility of an aging housing reconstruction project in the neighborhood. In the coefficient of the Stage 02 variable, it can see that the housing in the 400m, which consists of stage 02 level, is about 9% higher. The surrounding housing prices rose 2 percent at Stage 01, and the reason for the larger volume of housing reconstruction is that stage 2 is the period of reporting for association establishment. The stage after the establishment of a union is a period of conflicts within the neighborhood through prior research. With the relocation of apartments undergoing such problems and housing reconstruction taking place, surrounding apartments, which have aged more than 20 years, can be expected to be rebuilt due to the relocation of apartments. This is a result of the expected psychology by eliminating uncertainty in the housing market. (Clapp, J. M. et al, 1995; Kim et al, 2015) This stage is defined as the period of actual reconstruction work happening. Although there is a negative effect on the environment surrounding the site, the actual construction is done and the expectations values reflected are maintained. In Stage 04, which is the last step, the price of a house within 400 meters around a housing reconstruction is about 11 percent higher. This stage is from the move-in phase. Existing old buildings have disappeared, improving the environment in the neighborhood, and expectations of possible housing reconstruction have been influenced by the positive effects. Of course, for apartment complexes undergoing housing reconstruction, 4.9 percent higher than other houses, as shown in the Self-Reconstruction variable.

Model 2 is an example of an extension of the influence range of 400m to 800m. The physical characteristics and the coefficient of the local characteristic variables are derived almost as similar to

model 1. The coefficient of value of the Stage 01 variable, which can be seen within 800 meters of the housing reconstruction of Model 2, negatively affects housing prices by about -3%, but is not statistically significant. Based on the 800m nearby, the statistical values that were significant for Stage 02 and Stage 03. In the Stage 02 variables, 5.8% and 4.2% were found to be high in the Stage 03, compared to the 800-meter neighborhood where housing reconstruction is taking place. Although the zone is less affected than the zone of influence within 400 meters, it reflects the expectation of reconstruction as well as physical changes such as migration and demolition. For apartment complexes undergoing housing reconstruction, the coefficient for the Self-Reconstruction variable is 0.064, which is about 6.4% higher than that of other houses.

4.3 Determinants of Apartment Sale Prices of Less than 20 Years of Building

Estimates of the housing price model for the impact of nearby home reconstruction are shown in [Table 11] the less than 20 building years in sale market. Model 1 gives an estimate of the random intercept model, including the dummy variables, with an impact zone of 400 meters for surrounding housing reconstruction. Model 2 specifies the scope of the impact zone for nearby housing reconstruction to be 800m, resulting in the derivation of the dummy to estimate the random slice model. Model 1 and 2 have an Intra-class Correlation Coefficient (ICC) value of 0.761, 0.760, respectively, indicating the characteristic variables of the upper-level apartment complex. Model 1 and 2 have an explanation ability of about 74.8% and about 75%. In addition, the results of the VIF analysis do not exceed 2, and since there is no tendency in the residual graph, the analysis has been validated.

First, looking at the physical characteristics of Model 1, when size increases by 1%, apartment prices increase by about 1%. When the floor variable also increases by 1%, apartment prices increase by about 0.3%. In summary, the larger the household size of apartments, the higher the number of floors, the higher the apartment price is formed, showing a similar result value to the preceding studies. However, the building year, which is a physical characteristic variable, decreases apartment prices by 0.09 percent if the building is older than 1 percent. In general, buildings are depreciated as they get older, and prices generally fall. This model was analyzed for apartments under 20 building years, therefore a general housing market is depreciation by how much construction age increases. Based on the location characteristics of Model 1, an elementary school or subway station within 400 meters may positively affect the price of an apartment, but it is not statistically significant. The statistically significant variable is when there is an entrance to the Han River entrance within 400 meters. This variable has a positive effect on the price of apartments, and if there is an entrance to the Han River within 400 meters, housing prices will be high at about 39.8 percent. In addition, for the Wirye-dong area, variables related to the new town area are not statistically significant.

		Sale less than 20 years of housing	
	Variables	Model 1 (400m buffer)	Model 2(800m bufferl)
Physical Characteristics	Size	0.010***	0.010***
	Floor	0.003***	0.003***
	FAR	0.000	0.000
	Building age	-0.009***	-0.009***
	Household (over 500)	0.406***	0.406**
Locational Characteristics	Elementary 400m	0.010	0.013
	Subway 400m	0.006	0.005
	Hanriver Entrance 400m	0.398*	0.391*
	Wirye-dong (From. 200801)	-0.025	-0.030
Reconstruction Characteristics	Stage01	-0.057***	-0.033***
	Stage02	-0.055***	-0.018***
	Stage03	-0.064***	-0.035***
	Stage04	-0.055***	-0.013
	Self-Reconstruction	omitted	omitted
Transaction Characteristics	2006.01 – 2018.06 (Dummy 150)	Included	Included
Intercept		9.525***	9.529***
Number of obs. / groups		32463 / 387	32463 / 387
Adj. R^2		0.748	0.750
ICC		0.761	0.760
AIC		-42910.01	-42786.85
BIC		-41526.01	-41402.85

Significant codes: 0.001 '***' 0.01 '**' 0.05 '*'

Table 11. Result of Sale market less than 20 years of housing

Based on the influence of Model 1 near the 400m zone, the price of housing reconstruction is about 5.7% lower in the 400m area, compared to the areas where housing reconstruction is not underway. This step is when the repair area is designated and the designer is selected. It is a possibility that a housing reconstruction will take place in the surrounding areas, resulting in alternative goods. -5.5%, -6.4% and -5.5% of the parameters of Stage 02, 03, and 04. Along with the earlier results, the positive externalities of the reconstruction described in the preceding study can be attributed to reconstruction with a construction period of more than 20 years, and the negative externalities are experienced in the transactions with less than 20 years built. It is seen as a replacement for new housing and is sharing the same neighborhood. (Ha, S. K., 2004; Park Eun-sook & Choi Mak-joong, 2015; Liu, Y et al, 2017)

Model 2 is an extension of the influence range of 400m to 800m. The physical characteristics and the coefficient of the local characteristic variables are derived almost as similar to model 1. Given the near effects of model 2's housing reconstruction within 800m, the Stage 01 variable shows a low price of about 3.3% if it is within 800m of housing reconstruction. Stage 02 and Stage 03 produced significant statistical values. About -1.8% to 3.5% of the total cost of housing reconstruction

compared to those that do not. Stage 02 is an association establishment ~ a demolition reporting period that shows less negative effects than other phases. In some cases, migrants from apartments undergoing reconstruction migrate to the market for rent in the nearby apartment market until the reconstruction is completed. Therefore, it can be seen that Stage 02 has less negative effects than other phases. The effect on the formation of alternative materials due to housing reconstruction was greater.

4.4 Determinants of Apartment Rent Prices

The estimate of the housing price model for the impact of nearby housing reconstruction is as shown in [Table 12]. Model 1 includes a dummy variable with an impact zone of 400m, and Model 2 specifies the scope of the impact zone of nearby houses to be 800m, and estimates a random intercept model. The ICC value of Model 1 and 2 is 0.671 and 0.668. The explanatory availability for Models 1 and 2 is approximately 60%. In addition, the results of the VIF analysis do not exceed 3 and since there is no tendency in the residual graph, the analysis has been validated.

		Rent	
	Variables	Model 1 (400m buffer)	Model 2 (800m buffer)
Physical Characteristics	Size	0.008***	0.008***
	Floor	0.001***	0.001***
	FAR	0.000	0.000
	Building age	-0.008***	-0.008***
	Household (over 500)	0.136***	0.136***
Locational Characteristics	Elementary 400m	0.018	0.019
	Subway 400m	0.041*	0.043*
	Hanriver Entrance 400m	0.505***	0.502***
	Wirye-dong (From. 200801)	0.067	0.074
Reconstruction Characteristics	Stage01	-0.022***	0.003
	Stage02	0.013*	0.022***
	Stage03	0.005	0.013**
	Stage04	0.011	-0.018
	Stage 01: Self-Reconstruction	0.042***	0.025***
	Stage 02: Self-Reconstruction	-0.082***	-0.061***
Transaction Characteristics	Transaction type (Monthly rent = 1)	0.010***	0.010***
	2011.01 – 2018.06	Included	Included
Intercept		4.120***	4.123***
Number of obs. / groups		102522 / 439	102522 / 439
Adj. R^2		0.609	0.607
ICC		0.671	0.668
AIC		-80412.18	-79797.89
BIC		-79382.09	-78767.80

Significant codes: 0.001 '***' 0.01 '**' 0.05 '*'

Table 12. Result of rent market

First, looking at the physical characteristics of Model 1, when size increases by 1%, apartment prices increase by 0.8%. When the floor variable also increases by 1%, apartment prices increase by about 0.1%. In summary, the physical characteristics outcomes show a similar result value to the preceding studies. In addition, the building age is more than 1% older, and the apartment price is -0.8% lower. In general, buildings are depreciated as they get older, and prices generally fall. This model analyzes the apartment for rent. Through prior research, the market for rent contain use value, not investment value. (Lee & Lee, 2015) Based on the location characteristics of Model 1, an elementary school or subway station within 400 meters may affect the price of an apartment, but it is not statistically significant. The statistically significant variable is when there is an entrance to the Han River within 400 meters. This variable has a positive effect on apartment prices, and if there is an entrance to the Han River within 400 meters, housing prices will be high around 50.5%. In addition, for the Wirye-dong area, variables related to the new town area are not statistically significant.

According to the 400m neighborhood effect of Model 1, the price of housing reconstruction is about -2.2% lower in the 400m area where housing reconstruction is taking place in the surrounding areas. In stage 01, If reconstruction is carried out in the vicinity, it can be seen as a hindrance factor that inhibits the residential environment, such as construction. When the possibility of rebuilding begins, such concerns can affect the surrounding market for rent. It has 1.3% at Stage 02. Afterwards, Stage 03 and Stage 4 affects positively the surrounding housing market, but is not statistically significant. First, in Stage 2, existing reconstruction apartments will be took down, and existing residents will move out. In the preceding study, migration from a reconstruction complex tends to move to surrounding areas. Therefore, the price of Stage 02 rises 1.3 percent.

Model 2 is an example of an extension of the influence range of 400m to 800m. Although there is a significant degree of difference between the physical characteristics and the coefficient of the local characteristic variables, the direction and influence were derived almost as similar to that of model 1. If it looks at the neighborhood impact within 800m of the reconstruction of the house in Model 2, it can see the result different from the nearby effect within 400m. The effect of housing reconstruction on Model 2 is derived in the opposite direction. Of course, the size of the price change is not large effect. 2.2% in Stage 2 and 1.3% in Stage 3. Stage 1 and Stage 4 is not statistically significant. 800m buffer is a space where distances occur compared to 400m compared to areas where reconstruction is taking place. According to Kim (2017), the demand for migration to administrative-dong as the reconstruction progresses is small by 7 percent, but it can be seen as 50 percent higher in the same district. As such, in extending the range of myopia, it is also possible to see that changes in the rent market can be affected by the amount of migration demand. The expanded 800m in 400m is believed to have more of this influence. Stage 04 is not a significant variable, but it can be seen that it has a negative impact on people escaping from the surrounding rent market since it is time for people to move into a new apartment.

V. Discussion

The main results are as follows. For an aging housing market with more than 20 years of construction, prices rose, although there were slight differences in stages as reconstruction progressed around. This indicates that neighboring case studies have been conducted to eliminate uncertainty about whether or not to conduct a reconstruction project in this market. In particular, there is a significant price increase effect at the association establishment stage. The establishment of a union is the highest level of conflict among residents, and it greatly affects decision making. Overall, if this step is passed, reconstruction can be seen as an easy progression, reflecting the expected value of the reconstruction.

In the housing market with less than 20 years of construction, housing prices declined, although there were slight differences in each stage as the reconstruction of the neighborhood progressed. With the start of the project and the possibility of replacement caused by new housing supply, one can see the negative impact of the reconstruction project and the move-in to the new apartment.

Rent Market has a difference in its impact on reconstruction within 400m and reconstruction of 800m. Reconstruction occurring in the vicinity of 400 meters can be seen as a result of the construction of a new housing supply causing harm to the residential environment, such as noise. Reconstruction occurring in the vicinity of the 800m indicates higher prices because it contains more demand for migration and move-in like population move. However, in order to more accurately identify this, it is also necessary to analyze market reactions in wider proximity. The reconstruction project takes place for two years, which is equivalent to shocking the surrounding housing market in a short period of time. Further analysis of whether this continues to affect the long term is necessary.

Similar to the present analysis based on 20 years of construction, the results of this analysis could be obtained as compared to 25 years of reference. In other words, the results of the study can be considered robust. However, there is a need for research in that the replacement materials of apartments are limited to apartments. House replacement goods can also lead to detached houses, etc. In addition, this study is meaningful in that it produces generalized results through statistical methodologies. However, the process of rebuilding is not really smooth. In other words, it is a development that frequently changes businesses. Therefore, it is necessary to perform individual site studies to find parts of these changes.

VI. Conclusion

This study was designed to analyze how housing reconstruction processes affect the price of nearby houses. The 16th phase of the housing reconstruction was to be defined by four stages of operational definition, and the impact of housing price was to be reported on the surrounding area according to the Each Stage. As a result, housing reconstruction is affected differently depending on the situation of the housing market and the extent of neighborhood.

This study has important implications in terms of policy. As reconstruction apartments for reconstruction, regarded as one of the reasons for the rise in housing prices in Seoul, the regulations on over-profit recovery and safety diagnosis are being tightened under the logic that the price of housing will rise. This possibility is seen as having a negative impact on the price of surrounding apartments less than 20 years of construction. Rather, the start of the new apartment building created a free competition for market changes. In other words, price competition could also occur in housing goods. Therefore, such market changes are likely to lead to overall housing price stability. However, the new housing supply will be a chance to meet demand and supply in the housing market due to the increase in housing supply. Also, as the results of the study show, the price increase for nearby houses is not significant.

In addition, most of the Seoul area has been developed. Therefore, housing reconstruction is needed for new housing supply, and housing reconstruction can be seen as a source of housing in Seoul. In Seoul, apartment prices are known to have varied depending on the region as much as the size of the market. (Kim, 2016) The study was aimed at Songpa-gu, Seoul, so generalization has limitations that can lead to an overinterpretation. Also, as each stage of reconstruction is aggregated, there are limitations that are beyond understanding the individual influences of each stage.

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